MATERIAL PUMP

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of the filing date of U. S. patent application 60/537,774 filed January 20, 2004, assigned to the same assignee as this application. The disclosure of U. S. patent application 60/537,774 is hereby incorporated herein by reference.

FIELD OF THE INVENTION

This invention relates to material pumps. It is disclosed in the context of a pump for pumping, for example, coating material (hereinafter sometimes paint), but is believed to be useful in other applications as well.

BACKGROUND OF THE INVENTION

Various types of material pumps are known. There are, for example, the pumps illustrated and described in U. S. Patents: 4,009,971; 4,397,610; 5,094,596; 5,220,259; 5,228,842; 5,336,063; 5,632,816; 5,725,150; 5,725,358; 5,746,831; 5,787,928; 5,944,045; and, 6,533,488, and references cited therein. There are also systems such as, for example, the Ransburg E-Z Flow system, and Binks A41-78-R3 EXEL™ Pump Series Binks®, ITW Industrial Finishing, 2002. There are also the disclosures of U. S. S. N. 10/232,454, filed August 30, 2002, titled Multiple Component Metering And Dispensing System, and U. S. S. N. 10/254,121, filed September 25, 2002, titled Two-Component Spray Gun With Solvent Flush/Blend, both assigned to the same assignee as this application. There is also the disclosure of Electric-Powered Triumph™ 9000 Reciprocator For Use With Graco Pumps (1994). The disclosures of these references are hereby incorporated herein by reference. This listing is not intended to be a representation that a complete search of all relevant art has been made, or that no more pertinent art than that listed exists, or that the listed art is material to patentability. Nor should any such representation be inferred.

DISCLOSURE OF THE INVENTION

According to a first aspect of the invention, an assembly of multiple fluid pumps is provided. Each pump includes a movable component. A crank is coupled to the movable component. At least two of the movable components define between them a

non-zero included angle.

Illustratively according to this aspect of the invention, the crank comprises at least two throws, the apparatus further including at least two connecting rods, the crank being coupled to the movable components by the at least two throws and the at least two connecting rods.

Illustratively according to this aspect of the invention, the at least two throws comprise at least three throws, one of the at least three throws defining substantially equal included angles with the other two of the at least three throws.

Illustratively according to this aspect of the invention, the at least three throws comprise n throws, n an integer greater than 2, each throw making included angles with two others of the n throws, each said included angle being about 360°/n.

According to another aspect of the invention, an assembly of multiple fluid pumps is provided. Each pump includes a movable component. A cam is coupled to the movable component. At least two of the movable components define between them a non-zero included angle. The assembly further includes at least two followers. The cam is coupled to the movable component by the at least two followers.

Illustratively according to this aspect of the invention, the cam is configured to drive at least two of the pumps such that one of the at least two pumps reaches the beginning of an exhaust stroke at substantially the same time that the other of the at least two pumps reaches the beginning of a priming stroke.

Illustratively according to this aspect of the invention, the apparatus comprises m cams, m an integer greater than or equal to 2, each cam including p lobes, p an integer greater than or equal to 2, a line drawn between peaks of two adjacent lobes of one of the m cams making non-zero angles with lines drawn between peaks of any two adjacent lobes of another of the m cams.

Illustratively according to the invention, the pumps are coating material pumps.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may best be understood by referring to the following detailed description and accompanying drawings which illustrate the invention. In the drawings:

Fig. 1 illustrates a fragmentary, partly sectional side elevational view of a composite pump constructed according to the invention;

Fig. 2 illustrates a fragmentary sectional view of the embodiment illustrated in Fig. 1, taken generally along section lines 2-2 thereof; and,

Fig. 3 illustrates a partly broken away top plan view of a composite pump constructed according to the invention.

DETAILED DESCRIPTIONS OF ILLUSTRATIVE EMBODIMENTS

The fluid output pressure from certain positive displacement pumps, such as reciprocating piston type fluid pumps, typically exhibits pressure pulses. An example of such pumps is a four ball pump of the type illustrated in, for example, Binks® A41-78-R3 EXEL™ Pump Series Binks®, ITW Industrial Finishing, 2002. In such a pump, as the pistons reverse directions, there is a negative-going pulse in the output fluid pressure. Although other types of pumps, such as rotary pumps and the like provide a steadier flow with fewer and/or less dramatic changes in output fluid pressure, most such pumps expose the fluids they pump to considerable shear stress. In many applications, such as, for example, the pumping of certain coating materials which are continuously circulated in a coating material circuit, exposure of the recirculating coating material to high shear can adversely affect the coating material's recirculation life.

Referring now to Figs. 1-2, a composite pump 120 includes multiple fluid pump sections 120-1, 120-2, . . . 120-n, only one of which is illustrated. Typically, the components of the composite pump are supported in a frame 121. Each pump section 120-1, 120-2, . . . 120-n includes an operating rod 122-1, 122-2, . . . 122-n, respectively. The pump 120 further includes a crankshaft 124 rotatably mounted in suitable bearings. Crankshaft 124 has throws 124-1, 124-2, . . . 124-n. Operating rods 122-1, 122-2, . . . 122-n of pump sections 120-1, 120-2, . . . 120-n, respectively, are coupled by connecting rods 126-1, 126-2, . . . 126-n, respectively, to throws 124-1, 124-2, . . . 124-n, respectively.

When viewed from an end 128 of crankshaft 124, the throws 124-1, 124-2, . . . 124-n illustratively make equal angles with adjacent throws 124-1, 124-2, . . . 124-n. It should be understood, however, that throw 124-1 need not be offset by equal angles between throw 124-2 and 124-n. Indeed, throw 124-m and throw 124-(m - 1) or 124-(m + 1), $1 \leq m \leq n$, could make angles of 180° with respect to each other. It simply means

that throw 124-m lies at equal angles between some two of the remaining throws 124-1, 124-2, . . . 124-(m - 1), 124-(m + 1), . . . 124-n. It should further be understood that it is not necessary for throws to be offset at equal angles from each other. For example, the invention may be practiced using a crankshaft having only two throws which are angularly offset from each other by, for example, 90°.

The pistons of pump sections 120-1, 120-2, . . . 120-n are driven out of phase to provide a supply of the fluid which has reduced pumping pressure pulses. Any angular orientation in which one of the pump sections 124-1, 124-2, . . . 124-n is not to be at the end of a pumping stroke when another of the pump sections 124-1, 124-2, . . . 124-n reaches the end of its pumping stroke and begins its priming or intake stroke will reduce the negative-going pulse, thereby smoothing the flow of the pumped fluid. The crankshaft 124 illustratively is driven by an AC motor 136 through a right angle gearbox 138.

In another embodiment of the invention illustrated in Fig. 3, a composite pump 220 constructed according to the invention includes multiple fluid pump sections 220-1, 220-2, . . . 220-n supported in a frame 221. Each pump section 220-1, 220-2, . . . 220-n includes an operating rod 222-1, 222-2, . . . 222-n, respectively. The pump 220 further includes a crankshaft 224 rotating one or more suitably shaped, for example, somewhat elliptical or cardioid shaped, cams 226-a, 226-b, . . . 226-m. A follower 228-1, 228-2, . . . 228-n is coupled to each respective operating rod 222-1, 222-2, . . . 222-n. The respective followers 228-1, 228-2, . . . 228-n are coupled to each other in opposed pairs, 228-1, 228-2; 228-3, 228-4; . . . 228-(n - 1), 228-n by coil tension springs 230, so that they are continually urged against camming surfaces 232 of respective cams 226-a, 226-b, . . . 226-m. In this way, as one of the respective opposed sections 228-1; 228-3; . . . 228-(n - 1), reaches the end of its pumping stroke, the other of the respective opposed sections 228-2; 228-4; . . . 228-n reaches the beginning of its pumping stroke, thereby smoothing the flow of the pumped fluid.

Where there are multiple cams 226-a, 226-b, . . . 226-m, the cams 226-a, 226-b, . . . 226-m may also be oriented with their lobes at non-zero angles to each other. For example, if the cams 226-a, 226-b, . . . 226-m are somewhat elliptical, having lobes at the two opposite ends of their major axes, the major axes of the cams 226-a, 226-b, . . . 226-m may be oriented at non-zero angles to each other so that the pumping and priming strokes of each opposed pair 220-1, 220-2; 220-3, 220-4; . . . 220-(n - 1), 220-n of pump

sections are out of phase with those of the other opposed pairs 220-1, 220-2; 220-3, 220-4; . . . 220-(n - 1), 220-n of pump sections. This arrangement further smooths the flow of the pumped fluid.